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Proceedings of a Workshop on Effects of Land Use Practices on Fish, Shellfish, and their Habitats on Prince Edward Island

Regional Advisory Process
Gulf Fisheries Management Region

6 - 10 December 1999
Charlottetown, Prince Edward Island

David K. Cairns, Editor

Science Branch
Department of Fisheries and Oceans
Box 1236, Charlottetown
Prince Edward Island C1A 7M8
cairnsd@dfo-mpo.gc.ca

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Foreword

These Proceedings are a record of the discussions at a workshop on effects of land use practices on fish, shellfish, and their habitats on Prince Edward Island, which was held 6-10 December 1999. They were prepared by volunteer rapporteurs and reviewed by all participants at or following the meeting. The report records as faithfully as possible the contributions and discussion that transpired at the meeting. However, the individual interpretations and opinions expressed at the meeting are not necessarily scientifically sustainable or supported by other participants. No statements are to be taken as reflecting the consensus of the meeting unless they are clearly identified as such. Moreover, additional information and further review may result in a change of decision where tentative agreement has been reached.

Avant-propos

Le présent compte rendu relate les discussions qui ont eu lieu lors d'un atelier tenu du 6 au 10 décembre 1999, et qui portait sur les effets de l'utilisation des terres sur les poissons, les crustacés, les coquillages et leurs habitats à l'Île-du-Prince-Édouard. Il a été établi par des rapporteurs volontaires et a été examiné par tous les participants, à la réunion ou après celle-ci . Il expose aussi fidèlement que possible les discussions et arguments présentés. Toutefois, les interprétations et opinions exprimées par certains participants ne sont pas nécessairement fondées scientifiquement ou appuyées par les autres participants. Aucune déclaration ne doit être considérée comme une expression du consensus des participants, sauf s'il est clairement indiqué qu'elle l'est effectivement. En outre, des renseignements supplémentaires et un plus ample examen peuvent avoir pour effet de modifier une décision qui avait fait l'objet d'un accord préliminaire.

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ABSTRACT

A workshop was convened on 6-10 December 1999 in Charlottetown to assemble and review scientific data related to impacts of land use practices on aquatic resources of Prince Edward Island. The workshop addressed land use impacts in the categories of sedimentation, livestock access to watercourses, toxic chemicals, and nutrient release on estuaries. Findings are reported in a Habitat Status Report, and in an edited volume (in preparation) which contains papers presented at the workshop. The present report outlines meeting structure and objectives, records oral discussion following presentation of working papers, and lists participants.

RÉSUMÉ

Un atelier a été convoqué le 6 au 10 décembre 1999 à Charlottetown afin d'assembler et de réviser des données scientifiques traitant des impacts des habitudes d'utilisation des terres sur les ressources aquatiques de l'Île-du-Prince-Édouard. L'atelier s'adressait aux impacts dans les catégories de sédimentation, l'accès du bétail aux cours d'eau, les produits chimiques toxiques, et les apports des matières nutritives dans les estuaires. Les trouvailles sont rapportées dans un Rapport régional sur l'état de l'habitat, et dans un tome (en préparation) qui contient les rapports présentés dans l'atelier. Ce rapport décrit la structure et les objectifs de l'atelier, donne un compte-rendu de la discussion orale qui suivait la présentation des rapports de travail, et présente une liste des participants.

INTRODUCTION

Background

Prince Edward Island (PEI) is Canada's only fully insular province. Because it is surrounded by water, aquatic resources have always been a major part of the economic and ecological make-up of the province. PEI's coastline is deeply indented with bays and estuaries, and its short rivers were, in their original condition, virtually free of barriers to migrating fish. For these reasons, freshwater and estuarine biotas have particular importance on PEI.

In the 1800s, much of PEI's surface was cleared for agriculture. Farming remains the cornerstone of the provincial economy, and in recent years there has been a major expansion of potato cultivation, which is the largest agricultural sector. During the 1990s, the environmental effects of agriculture and other land use activities assumed a high public profile on PEI. Much of this attention focussed on effects on aquatic systems. Public concerns were fuelled by trout and salmon kills in streams that received drainage from potato fields. Effects of siltation from agriculture, forestry, and road building also drew much public attention.

Public concern about land use impacts on PEI has led to a host of reviews, fora, and hearings. Although the nature and extent of impact of land use practices on aquatic systems is a scientific question, scientific research has not featured prominently in discussions of this topic. Consequently, a workshop was held in December 1999 to table, scrutinize, and synthesize available scientific information on land use impacts on PEI's aquatic resources, and to make recommendations for mitigative measures and for future research.

Questions

1. What is the nature and extent of physical alteration and of silt, chemical, bacterial, and nutrient input into PEI watercourses due to land use practices?
2. What effect do these alterations and inputs have on fisheries resources in freshwater and estuaries?
3. What is the rank order of these alterations/inputs in terms of the degree of negative impact on fisheries resources?
4. What measures or processes could be put in place to reduce negative effects of land use practices on PEI fisheries resources?

Objectives

1. To assess the effects of past and current land use practices on fish and shellfish and their habitats in fresh water, estuaries, and bays of Prince Edward Island,
2. To place the impacts on fisheries resources resulting from land use practices on a scale of relative importance,
3. To examine measures or approaches that would reduce negative effects of land use practices on fish and shellfish and their habitats in PEI, and
4. To identify research activities that would increase understanding of how land use affects fish and shellfish and their habitats.

Scope

This Workshop concerned land use and fish and shellfish and their habitats on Prince Edward Island. Information from other areas was considered if it illustrated principles that may shed light on the PEI situation. Land use referred to activities in the terrestrial environment, including agriculture, road construction and maintenance, forestry operations, and residential, commercial, and recreational development, that may alter the physical, chemical, or biological properties of aquatic habitats. Impacts from industrial plants, from municipal sewage systems, and from dams were not considered except for purposes of comparison. Although the RAP was directly concerned only with PEI, its findings ought to have application in other areas with similar land use patterns.

Principal Issues

Siltation

Effects on freshwater habitat and on salmonids and other fish which use this habitat.
Effects on estuarine and bay habitat and on fish and shellfish which use this habitat.

Livestock in or near streams

Physical effects on fish habitat: turbidity, alteration of banks and streamside vegetation.
Release of bacteria: effects on fish and shellfish, bacteria levels in relation to standards for consumption of fishery products.
Effects of manure on stream chemistry and on the stream's ability to support fish.

Toxic chemicals

Effects of classic toxic chemicals (typically persistent, acutely toxic, and bio-magnifying) on fish, shellfish, and their food.
Effects of endocrine disrupter compounds on aquatic organisms.

Nutrient releases

Input of nutrients into watercourses and their effects on aquatic plant growth.
Estuarine eutrophication and its effect on fish and shellfish.

WORKSHOP STRUCTURE

Workshop Planning and Participation

The Workshop was organized by a committee which represented Fisheries and Oceans Science Branch and the PEI Department of Technology and Environment. The invitation list was multi-disciplinary in nature, and included most scientists who have gathered data relevant to aquatic impacts of land use on PEI in recent years. Invitees included representatives from the Department of Fisheries and Oceans, the PEI Department of Technology and Environment, the PEI Department of Fisheries and Tourism, the PEI Department of Agriculture and Forestry,

Environment Canada, the Nova Scotia Division of Inland Fisheries, the University of Prince Edward Island, the University of New Brunswick, and McGill University.

The Workshop was chaired by André Ducharme (Fisheries and Oceans, retired). The Convenor was David Cairns (Fisheries and Oceans, Charlottetown). Official workshop panel members included the Chair, authors, and referees. Workshop sessions were open to the public, and members of the public and others actively contributed to discussions. Appendix 1 lists panel members and other participants.

Workshop Format

All sessions were held at the Farm Centre, University Avenue, Charlottetown. The Workshop opened at 10:30 on Monday, 6 December 1999. Presentation and discussion of working papers continued through Wednesday, 8 December. Oral presentations of working papers were followed by the comments and questions of the referee assigned to the paper. After this, the floor opened to questions and comments by panel members and other participants. Thursday and Friday, 9-10 December, were devoted to preparation of a draft Habitat Status Report. The full agenda is presented in Appendix 3.

Output

DFO. 2000. Effects of land use practices on fish, shellfish, and their habitats on Prince Edward Island. DFO Maritimes, Regional Habitat Status Report 2000/1E.

Cairns, D.K. (ed.). Effects of land use practices on fish, shellfish, and their habitats on Prince Edward Island. Canadian Technical Report of Fisheries and Aquatic Sciences in prep.

Proceedings of a workshop on effects of land use practices on fish, shellfish, and their habitats on Prince Edward Island (this document).

RAPPORTEUR REPORTS

Working Paper: Cairns, D.K. 1999. Land use and aquatic resources of Prince Edward Island streams and estuaries - an introduction. RAP WP 99/66.

Referee: Bruce Smith

Rapporteur: Daniel Caissie

Issues/Concerns (including response):

The author provided a general overview of land use and aquatic issues in PEI. It was mentioned that over the years initiatives have been made to better understand land use through a Royal Commission on Land, task forces, etc. A historical perspective on the geological formation of the Island was presented. It was noted that PEI has erodable soil as a general characteristic. It

was also noted that the groundwater component on the island is very important, which tends to keep the river and stream cooler in the summer. Data were presented on the number of farms over the past decades and these numbers showed a decline of farms over the years, although the farms are becoming larger. Individual are leasing land rather than farming themselves. The biggest change in agriculture has been the increase in potato farmed area. The author also described the current planting rotation on the island. This typically follows a three-year cycle, but some fields are planted in potatoes in a two-year cycle.

The important of the oyster industry and the blue mussels was presented. There are four major commercial diadromous fisheries on the island: eels, gaspereau, smelts and silverside. The importance of the recreational fisheries is high at $4.5 million.

Comments from Referee

Bruce Smith: Because of the nature of this paper, I reviewed the document as a more general overview. The referee provided comments on why the current crop rotation is a three-year rotation cycle.

Other Comments

Denis Haché: A comment was provided on the reliability of reported fish landings. It was mentioned that a lack of reporting of fisheries catches could significantly under-estimate fish landing number. Individuals don't always report landings.

Gerard MacDougall: Is there a method to better estimate the mis-reporting?

Irené Novachek: Were the fluctuations in the catch or landing of eels and others fisheries related to the biology of the species? Are the fluctuations part of an interrelation of the biology rather than due to other factors?

Answer Cairns: Eels have been observed to decline in the ocean and recruitment is the best explanation at this point. Overfishing alone does not explain the decline. Landings are the best information that we have to study eel populations at this time. It is not a good idea to look at biology of eels to answer some of these questions because we have no good database on eel population.

Bob Bancroft: What are the markets for silversides?

Answer Cairns: These are sold as food for exotic birds in zoos.

Rick Cunjak: Do have any data on the increase in forestry harvesting activities? What are the present guidelines?

Answer Cairns: We will be discussing this issue later during this week.

Working Paper: Meeuwig, J. 1999. Predicting estuarine eutrophication in Prince Edward Island from land use patterns. RAP WP 99/67.

Referee: Rod Bradford

Rapporteur: Scott MacNeill

Issues/Concerns (including response):

Note: the oral presentation was made by Bruce Raymond, using overheads and notes supplied by Dr. Meeuwig. Dr. Meeuwig responded to questions via a telephone link.

Referee Comments

1. Models would have stronger relationships if there were a greater breadth of sampling
-Surface area of estuaries less accurate because of flushing
-possible bias in land use data...Some fields are left fallow.

2. Ecological considerations
Models show a very clear correlation between land use and phytoplankton biomass. Benefit: we can link land use to other known variables in estuary.

3. Management
If you set standard for phytoplankton biomass this will tell you total allowable phosphorous and nitrogen in system for mussel farming.

Q: Use of total Nitrogen? Any benefit to breaking down N further?

A: No nitrate and ammonia urea, variation is highly variable because some is recycled very quickly. I.e. mussels may cycle very quickly.

A: Expected that estuaries with mussels to have lower amount of phytoplankton biomass, and more nutrient cycling but this never held true. Need to substantiate water residence time.

Q Any benefit to developing more variable model instead of direct linear approach.

A. Yes, have started to use bootstrap, a more robust approach to nutrient loading in the system.

Panel comments
Q: Macro algae abundance in nutrient loading (*Ulva*): any relationship with macrophytes and loading?

A: Would like to see macro algae abundance, however didn't have time. But there is probably a good relationship. Phytoplankton does increase with loading, but an enormous amount is stored in macrophytes. There are places around world that consider sea lettuce a resource.

Q: Is chlorophyll a symbol of something wrong with estuary?

A: Depends upon management goals.... Too much of anything is a bad thing. Too much creates anoxic events. You may want to locate mussel farms in highly agricultural watersheds to remove some of nutrient loads.

Q: From work in Tracadie Bay coming to a conclusion, the major factor for mussel growth is not quantity of food in food but quantity of non-food that mussels must filter out and expel. Can you relate this to your model?

A: Yes good evidence for this from Boughton R. Different species have different adaptations for survival. Models to predict effect of land use on mussels need to include turbidity.

Q: Have you looked at loading from sea?

A: Yes, looked for trends with samples toward the ocean. Always a decline going from land - seaward.

Q: How far out are your samples collected?
A: Depends on watershed. In most estuaries, the most seaward station is within 300 m of the estuaries mouth / seaward headlands.

Q: Your opinion on effect of riparian vegetation on nutrient loading?

A: Yes, as amount of agriculture increases so does phytoplankton biomass. Forested area along a watercourse theoretically reduces phytoplankton biomass.

Working Paper: Aggett, D., G. MacDougall, and L. Murphy. 1999. Acts, regulations, policies and guidelines pertaining to the protection of aquatic environments on Prince Edward Island. RAP WP 99/68.

Referee: David Cairns

Rapporteur: Scott MacNeill

Issues/Concerns (including response):

Q: What is the status of the new Fisheries Act?
A: No movement forward; scuttled because of disagreement re partnering opportunities.

Q: What did drafts of the bill say?

A: Drafts defined things like water, temperature, as related to fish habitat requirements.

Q: Re section 34(1) of Fisheries Act, which deals with rearing and food supply. Allochthonous material from trees is important in headwaters. Does this mean that removing trees is an offence?

A: No not on PEI but there are rules in other jurisdictions.

Q: Private prosecutions have been launched in Ontario. Have such prosecutions been launched in the Maritimes? What does a private individual have to do?

A: No such prosecutions in the Maritimes. But it is easy; you just have to go swear before a justice of the peace, and a charge is laid. Courts seem a little more lenient with private citizen.

Q: What about judges making decisions about enforcing regulations.
A. You must assume the judge is an empty vessel, i.e. explain everything to judges with expert witnesses.

Q: Is it hard to convict under the Fisheries Act.
A: In our last two convictions we got convictions without proving the loss of a single fish...especially section 36.

Q. How does law protect exotics?

A. Same way as for introduced species.

Comment: 50% of fine goes to the person who takes the individual to court, but could also be found liable for court costs. Watercourse must have 72 hour flow between July 1 and Oct 1. Fisheries Act still applies to anything that contributes directly or indirectly to fish habitat.

Comment: Unless there is a commercially important fish species it is not considered fish habitat.
A: Not true.....but possible, based on Supreme Court decision, fish must be of some value.

Comment: Under pesticide control act individuals must follow directions on the label.

Q: More clarity on the planning act.
A: Apply to conservation of environmentally sensitive areas (protection).

Q: How many charges have been laid on PEI related to sediment?
A: Not very many. One two years ago. 9 full time officers in PEI, 5 part time. This is not enough.
There were two forestry cases last year on sediment

Q: What are drainage ditches protected under?
A: They are still considered a watercourse. Province can regulate contaminants in ditches, not necessary for them to be fish habitat.

Comment: A lot of success with creative sentencing. Some fine money goes to rehab work.

Working Paper: Cairns, D.K. 1999. Substrate sedimentation and salmonid densities in Prince Edward Island streams. RAP WP 99/71.

Referee: B. Bancroft

Rapporteur: Scott MacNeill

Issues/Concerns (including response):

Referee Comments

Point of clarification- most salmon juveniles would have had stocked parents, but no fish in study (very small fraction) would have been stocked themselves.

Point- data doesn't tell you a lot. We didn't really have trout habitat. Data shows population estimates are very low, because of many habitat problems.

Q: Seal River data are confusing. When dam lowered trout numbers lowered (why?)
A: Don't know

Q: Paper says sediment does not affect juvenile abundance, I disagree. Juveniles are there but habitat is not necessarily great. What we think as normal is probably really low, because of history of dams, and other habitat destruction variables.

A: Comparison may not be useful because of habitat degradation in other provinces as well. Limitations are noted.

Q: Problems comparing site to site, and not river to river, limitations with standing crop density.

A: River by river is tricky because limited data available, but comparison has not been done. This approach has ignored measurement of suspended sediments.

Q: Did you look at biomass and land use? What would happen if land use practices changed?
A: Trout are probably not food limited on PEI. One study looked at black fly abundance and drew this conclusion.

Comment: Relationship between salmon and trout interesting....Food is not limiting. Should have much higher densities. Why haven't more salmon taken over? This does show evidence of sediment impacting populations.

Q: Should look at baseflow in comparison to other Maritime rivers....same watershed would have 4-5 times more water than the mainland. Discharge much higher on PEI, continuous baseflow. Argument that PEI should have much higher densities. Something else coming into play.

Comment: Really can't compare data between Maritime provinces. Some streams rehabilitated, some pops have rebounded. Sites were picked out for indexing Atlantic salmon. Maybe not representative of watershed. Maybe we should look at biomass age classes.

Comment: All electrofishing methods are not the same. Confuses relationships because differing methodology. Maybe a relationship that is being masked.

Q: Study was initiated to see if we were making a difference, and visualizing what we could do. Sites were chosen based on differing characteristics. Most PEI sites were examined because no habitat enhancement. Mainland rivers different than PEI.

Cunjak: Comparisons are still valid between systems if you realize what the differences are, and are aware of them.

Working Paper: Caissie, D., and E. Arseneau. 1999. Substrate composition in the Morell River and other Maritime Province rivers: potential implications for Atlantic salmon fry emergence. RAP WP 99/70.

Referee: David Cairns

Rapporteur: Scott MacNeill

Issues/Concerns (including response):

Q: Do you think 25 samples is enough to generalize between mainland and PEI samples?

A: There was low error. But obviously there is variability. Every river is different but I think you can compare.

Q: Are there simpler methods? i.e. Proportion of fines.
A: Sieving gives a much more accurate measurement of composition.

Q: What is threshold effect....sediment builds to certain point and then gets carried away? Is this valid?

A: River limited by cross section. Takes a long time for fine sediment to move through the system and while these move others are entering the system.

Q: Does redd construction clean out fines?
A: Yes

Q: If there is no further input of sediment will it wash out of the system?

A: Yes, if the source is eliminated, yes over time it will clean out theoretically.

Q: Same technique at each site, what happens when you look at absolute values of fines.

A: You would have to compare it to kg of sample, but yes it would work. The only parameter that could be biasing your sample is large gravel. Not in PEI, not really any big rocks. Therefore PEI samples are less biased.

Q: Why did PEI have peak from medium sand in fines and not others.

A: Not sure. Maybe finer material washed through, this is all that is left, or PEI rocks break down in a medium fine sand component.

Working Paper: deHaan, R. 1999. Soil erosion on Prince Edward Island. RAP WP 99/69.

Referee: Bruce Raymond

Rapporteur: Rosie MacFarlane

Issues/Concerns (including response):

Referee Comments

Q: Farmers are concerned about having economic viability destroyed. What about cost of anti-erosion measures?

A: We try to promote concept of integrated erosion control - not just one practice. 60% of land base on 3 year rotation. That in itself will not solve problems on P.E.I. In higher slopes, 3 year rotation will not do the job. Integrated erosion control e.g. good rotation, residue management, can save $40/acre. Winter cover will cost you about $40-50/acre. Strip cropping does not cost. Can actually end up with a management system that will cost the same dollars out of pocket to produce crop of potatoes and have significant impact on sedimentation.

Sometimes structures needed. Program for producers that will assist them with any such endeavors. AERC program provides 66% cost sharing on any erosion control structures. $20 acre one time incentive for mulching. Land will be taken out of production (5% for erosion control structures) but once you've done it and you can control the runoff and have better moisture conservation, your profit on the entire field will be more than you would have without proper management. Biggest hurdle to overcome is changing the attitude. If producers are willing to integrate the practices, expenses will be rather minimal.

Q: Wilmot study: sediment loads they measured are horrendous/massive. How typical is this?

A: Not be surprised if those levels are probably common in intensively farmed watersheds across the province. The average concentrations are perhaps high on that one scenario, but peak concentrations probably similar. The average concentrations are perhaps high on that one scenario, but peak concentrations probably similar.

Q: Methods are not continuous in this work.

A: It is time consuming to analyze the samples and expensive but this is the best way to capture what is happening in the real world. Rainfall simulator test can determine relative benefit of a particular practice. Usually concentrated on one point in the rotation, a couple of week period of a rotation. Work on terracing: designed a terracing system to reduce it down to 3 tonnes/acre but reduced it to about 1 tonne/acre. Some fields, one in particular, had pretty severe erosion. This field now has much less than 1 tonnes/acre/year - as long as it is managed as it should be.

Q: Recent increases in potato acreage (110-115,000 acre), up from 65,000 about 10 years ago. Where are we heading, in terms of acreage?

A: Encouraging to see that it has stayed somewhat stable over the past 3 years. Our rotation has suffered because of it. See a lot of land that was in 3 year rotation, now 2 years potatoes in five. Would like to see those rotations not get any worse. Disturbing to see that the increased acreage is going into marginal land, increased topography, increased erosion potential. 8-10% slopes, need phenomenal management to reduce the erosion. There is good class II and III land that is currently not in potato production, so if acreage increases, we would hope that this would be the land. About 255,000 acres in potato rotation.

Lee Murphy: In incentive programs now, what are the checks and balances. What opportunities do you have to go back and check? Public money going in.

A: Right now, anyone entering into agreement must sign a 15 year contract to leave things in place. About 15,000 acres of strip cropping/terracing work in province. There has probably been about 300-400 acres that have reverted back to the old state. Most of that land was one landowner who had a couple of properties that had fair amount of conservation done. Same individual has been responsible for 3 fish kills this summer and has just been charged. The charges have opened a lot of eyes. The only stipulation is that they are signing a 15 year contract - both the farmer and the owner (on leased land). Surprising how many of these properties change hands. Am personally encouraged to see that for the most part, things are being left. Some of the management of some sites is undesirable. E.g. fall plough the forage crop in strip crop instead of residue management or spring tillage.

Q: What are current levels relative to background levels of erosion?

A: It is difficult to determine. If looking at a forestry situation, we could be looking at 1/10th of current levels. Land use and topography have tremendous impact. Can never cut erosion to zero. We strive to keep erosion to <3 tonnes/acre/year. Approximately 60-70% of potato fields on P.E.I. have excessive erosion rates.

Q: There was a question about erosion potential. Is it actual erosion?

A: Yes

Q: On the information sheet Ron handed out, there is mention that by ploughing up and down slope the farmer can minimize erosion.

A: On minimal slopes (2-3% grade) you can tolerate 800-1000 feet slope length of farming across slope. However, you can get preferential flow paths down the slope when ploughing cross slope on certain fields. On very small slopes, get less erosion when ploughing up and down than crossways. Once the slope is greater than 4%, the opposite holds true.

Daniel Caissie: Is the data on sediment loading based on suspended sediment? We also collected bottom sediment. Is there any way of collecting sediment that is actually coming off the field?

A: Yes, at sites, we have erosion plots. Another stage of monitoring. In P.E.I., we do not have monitoring sites that look at the entire field.

Daniel Caissie: How do these numbers compare?

A: The biggest problem with erosion plots is that they are not long enough to take into account rill erosion. They just measure sheet erosion, so they underestimate what the real loss is. Varies so much from field to field, there is no way you can cover every scenario.

Daniel Caissie: But it does give an idea of moderate to high.

A: Also use GPS equipment in fall. Profile the field and measure the surface. Go back in spring and measure rills to get an idea of the losses.

David Cairns: There are two sorts of motivation for farmers: long term self interest to protect soil productivity and a desire to protect the common good. What are the relative importance's of these motivations?

A: It varies from producer to producer. e.g. George Webster on his farm in Maple Plains. This producer takes real pride in what he can do to create wildlife habitat on his farm and in having good stream habitat on his property. Others are more concerned about individual properties. The education process is frustratingly slow. It works for some producers, others need threat of litigation.

David Cairns: How strong a case can you make that adopting these practices is in the farmers best long term interest?

A: Testimonials from farmers who have done things are extremely valuable. The best tool out there is having one producer talk to his neighbours.

David Cairns: Are there producers out there who can say, "I started doing this about 15 years ago, and my yield is better than my neighbour's?"

A: No, but we had yield monitors on potato harvesters for the past 10 years. We can track the location of the harvester with GPS. High compaction headlands and hollows in the field have lower yields.

Working Papers: MacNeill, S., and R.A. Curry. 1999. Abundance of juvenile brook trout (*Salvelinus fontinalis*) and sediment in Prince Edward Island streams. RAP WP 99/72 and Effects of sediment on juvenile brook trout survival to emergence. RAP WP 99/73.

Referees: Ron Gray (WP 72) and Simon Courtenay (WP 73)

Rapporteur: Rosie MacFarlane

Issues/Concerns (including response):

Ron Gray: Was surprised that you didn't find greater differences in juvenile densities between combined West River and Wilmot sites. Not surprising that brook trout may be more resistant to sediments. Wondering if there are other factors, for example in West River there are a number of different species of salmonids, e.g. Atlantic salmon, rainbows, speckled trout, others? What do your densities really mean? Were you surprised by the difference between the 2 watersheds? What does this mean to the reproductive potential of the two watershed?

Scott MacNeill: Higher number of salmonids in Wilmot. In West River, never found one rainbow or one salmon. In Wilmot, rainbows were fairly common. For fish > 10cm, higher numbers in Wilmot than in West. Perhaps downstream habitat is so degraded, that they move further upstream where not so bad. Hypothesizing that downstream habitat is so degraded that they move upstream.
A measure of density of fish in the stream does not give the answer you want. Biomass is one thing, length or size, age class structure, growth rates. Info is there, but not now at the stage to discuss.

Q: Did you have an opportunity to look at impact of sediments on aquatic invertebrates? Some are more resistant to sedimentation. In streams where there is greater than average sediment level, might expect more restricted diversity of animals. Fish move towards greater biomass of food.

A: We do have invertebrate collections but are only half way through analysis.

Q: What is this all about? Looking at how we are managing our habitat. Can the socio-economic objectives of society be compatible with environmental protection?. Can you suggest anything that could be done in terms of habitat management? From a science perspective, what should we be looking at?

Scott MacNeill: I was surprised at the high variability of survival in the streams. Small area of groundwater discharge had many redds with high survival. Twenty metres downstream, could

have very poor survival. If these areas were identified, they could somehow be offered protection. If this area were destroyed, we would lose a lot of productivity in the stream.

Ron Gray: Maybe a classification, maybe identify parts of the watershed that are really critical areas that should be protected.

Allan Curry: What are potential effects of groundwater contamination on actual incubation success of these eggs? Survival and overall reproductive success of these fishes. With these new guidelines in place to keep sediment out of streams, that is the first step. In some streams with groundwater discharge, probably saved the stream from being wiped out. Fish are spawning in areas that are not classified as trout spawning habitat because that is the only place available. They are adapting to the system, but because of the groundwater, there is some mitigating things going on there.

Simon Courtenay: You got a step function in the relation between survival and sediment. Produce these survivals in the lab with either sediments or chemicals?

A: No. But, if anyone else would like to do these studies in the lab, they would certainly help. They should be done.

Q: Another large study done on those two rivers - M. Gray et al. Do you have any sites in common?

Michelle Gray: Not sure. We had 3 sites on the Wilmot, but not sure if they are similar locations.

Allen Curry: Strictly the ecology on what is happening to the fish. Hopefully the other studies and other physiological measures will get wrapped up in package so we'll know for sure what is going on.

Rick Cunjak: The electrofishing work was done in August. Surprised how high the densities were and lack of apparent impact on the site, in terms of density. By late August, what is the likelihood that some of the densities in August are actually fish reared from outside and moving in, rather than from redds in that areas.

Scott MacNeill: Sites are far up in the headwaters as possible. Went to areas where they knew was discharge. Couldn't do it in June, because variability in emergence dates. Some still have yolk sacs in June. In Wilmot A. for sure no migration downstream. In Wilmot C, it was possible. Good chance that fecundity was higher in Wilmot than in West, but abundances are still the same. Abundance of redd counts compared with what the densities are.

Lee Murphy: Oxygen levels were reported to be >8mg/L.

Scott MacNeill: Average 9-10mg/L. Lee's point is that they are below saturation.

Q: Any histological analysis done on any mortalities to determine the cause of death? Gas saturation as a possible impact on these early stages.

Scott MacNeill: Tested the groundwater for gas saturation and it was not a problem.

Lee Murphy: In hatchery situations, water quality with re: gas saturation with regards to nitrogen is a problem and it isn't well understood in natural situation. There can be very high nitrogen fractions in groundwater.

Scott MacNeill: In normal limits as re: to the literature.

Lee Murphy: it has to be identified and ought to be looked at. Any signs of gas bubble trauma?

Allen Curry: All of these factors may be playing a role here.

Lee Murphy: shouldn't just focus on things we can see.

Daniel Caissie: McNeil sampler indicated fines component was predominant. Something in way it was analysed, was there any difference in way they did it as compared to ours? Did you see a fines component sticking out like we did?

Daniel Caissie: Water is mainly from groundwater origin and seeing 8 mg/L Oxygen seems high.

A: High for non-Island groundwater, but not uncommon for P.E.I.

Rob Bradford: Your conclusion: lower densities of juvenile trout in catchments with greater degree of agriculture. Figures suggest marginal differences. But individual years show greater difference. 1996 not much difference, but 1997 had greater difference. How firmly can one stand on that conclusion? Only thing significant was amount of fines and certain habitat types (undercut banks). Add full ANOVA to revisions.

Shawn Hill: Found that during electrofishing, rainbows and juvenile Atlantic salmon in Wilmot but not in West. Scott was far up in the headwaters, so that could explain it. Salmon found only in Wilmot C, but not too many.

David Cairns: Your data, # fish/cubic metre. When calculate densities #fish/metre squared. How do they compare with the densities that I reported yesterday.

Scott MacNeill: Much higher. Headwater areas. Maybe juvenile densities higher because of that.

David Cairns: Devil's advocate would say: what's the problem with agriculture.

Scott: further downstream you go, the more degraded the streams get. Fish abundance downstream seems to be less than in headwater areas. Concentrating the fish in those upstream areas. West is more spread out. Complicated - more going on.

David Cairns: Shawn Hill, what is your impression.

Shawn Hill: Has done redd counts this fall - he doesn't agree. Shawn would like to see the data.

Bruce Smith: Mention of LD50 levels for rainbow trout. Weren't sure on impact of brook trout in egg stage. Can we make jump from rainbows to brook trout. With one fish kill, we got 75% brook trout, 25% rainbow trout. Out of several thousand fish, there wasn't a rainbow trout amongst the deceased. Definitely difference intolerance level between species and between age classes within species.

Jamie Mutch - In some literature, found LC50 levels relatively similar for adult brook trout and adult rainbows. But there could be difference in lower age classes. In summer, rainbows are more tolerant to warmer temps. Brook trout could be under more stress already from warmer temperatures. Could be a behavioural thing as to what the fish do when they are stressed.

Rick Cunjak: I've never seen #fish/cubic metre used before but would be nice to see #/square metre for comparison.

Scott MacNeill: There is a reference in the literature where they went to cubic metre because of the difference in depth.

Rick Cunjak: Depends on the species. If you were dealing with salmon, it wouldn't make any difference. For comparison with other people's data sets, it would be nice to have in square metres.

Daryl Guignion: Getting yolk sacs still on fish in June. In Morell, trout spawn as early as October and as late as 3rd week in December. Could possibly have trout spawning that late. Have seen trout spawning where other trout have spawned or particularly salmon. Caution: sources of sediment may come from other sources other than agriculture e.g. highways. Sometimes it is not percent of agricultural land but rather percent with soil conservation practices in place. A single field can do more damage than other fields. Interested in work with pesticides in groundwater. This is something that has bothered Daryl - effect on whole process of providing detritus to the whole ecosystem. The whole sequence can be broken. This work needs follow up.

Jamie Mutch: Toxicity levels low. More work done on this out of Moncton lab. Toxicity testing, but problem getting exact formulation from the company.

Bruce Raymond: Environment Canada may not have found the kind of toxicities that the Mexican paper had reported. Until they do more sampling, we won't really know. Would be nice to have more than one season of data. Early life histories go through different sensitivity periods. Egg has protection, but once free swimming, the embryo is very sensitive.

Shawn Hill: Could you quickly go over how you determined groundwater influence in redd sites?

A: Marked redds each fall (15-20 each stream). And where emergent traps were selected, piezometers were put into ground. Sample at 25 cm. Measure pressure and do collection of discharge. All of the water analyzed was sent to Environment Canada.

Working Paper: Cunjak, R.A., D. Guignion, R. MacFarlane, and R. Angus. 1999. Survival of eggs and alevins of wild brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) in relation to fine sediment deposition. RAP WP 99/74.

Referee: John MacMillan

Rapporteur: Rod Bradford

Issues/Concerns (including response):

- **Ecological Issues**

1) It was noted that the Morell River is relatively unimpacted by agriculture. This raised the issue of whether the results could be considered typical for P.E.I. rivers. The consensus view was that the results represent a best case scenario for salmonid survivorship to emergence in P.E.I. rivers.

2) Survivorship of the control group of brook trout eggs held at the Cardigan Fish Hatchery was poorer than expected. This was attributed to a parent effect, although other factors could not be discounted absolutely.

3) The study indicated that survival to emergence for both Atlantic salmon and brook trout was negatively affected by siltation. Between-species differences in survivorship were evident. These served to reinforce the view that siltation had negative effects. Brook trout, which tend to spawn in areas of significant groundwater discharge (which reduces the negative effects), were impacted to a lesser extent than Atlantic salmon which do not utilize groundwater for spawning.

4) The potential impact on brook trout egg survivorship of differing ground water quality among-sites was not considered because this lay beyond the scope of study. General support was expressed for consideration of ground water quality in future studies.

- **Methodology**

1) The cylinder linking the emergence basket to the incubation basket clogged with silt under field conditions. This was not evident in comparable studies on New Brunswick rivers where sediment loading is lower. The presenter's recommendation that the apparatus be modified to accommodate in-river conditions on P.E.I. was accepted

2) The presenter's suggestion that future field experiments be based on a larger number of replicates per site was accepted.

3) Although it was agreed that the experiment demonstrated that siltation negatively affects survivorship to emergence, there was discussion regarding the extent to which estimates acquired from incubation baskets reflected those that would occur in a naturally spawned redd. The concern was whether or not an inability to resolve the proportion of the mortality attributable to the method (i.e., confinement in an incubation basket) from that attributable to siltation in a naturally produced redd would preclude the use of the data for enforcement (of the Fisheries Act). It was suggested that means to calibrate experimental results to the wild setting be explored.

4) It was suggested that sieving materials <2mm diameter from the substrate placed in the incubation baskets might over the duration of the experiment increase the volume of fines that accumulate in the basket (i.e., above those that would accumulate in a naturally produced redd. Modifications/additions to the sampling methodology could resolve the issue.

- **Management Consideration**

Siltation of spawning grounds for Atlantic salmon and brook trout negatively affects survivorship to emergence.

Working Paper: Smith, B., T. Dupuis, and R. MacFarlane. 1999. Physical watercourse enhancement on PEI: methods, extent, and effects on habitats and biota. RAP WP 99/79.

Referee: Daryl Guignion

Rapporteur: Rod Bradford

Issues/Concerns (including response):

1) The benefits of stream enhancement programs are evident in the colonization by fish of areas cleared of silt. However, protocols to measure the effectiveness of stream enhancement programs are either non-standard among community groups, or for many watercourses have not been implemented. Quantitative, consistent assessments of the effectiveness of the programs (i.e., as measured by higher fish abundance) are therefore not possible.

2) The possibility that construction of in-stream sediment traps remove large substrate materials that could be sorted and replaced in the stream has not been explored.

3) Sediment traps remove bedload from the water column but do not represent a long-term measure for watercourse improvement. The transport of sediment to the watercourses must be controlled.

4) Government is still responsible for fish and fish habitat. Enforcement of the relevant federal and provincial legislation, in the event that education and mitigation fail, needs to be pursued.

- **Management Consideration**

Physical watercourse enhancement programs can partially mitigate the negative effects of siltation on fish and fish habitat. High discharges of silt into P.E.I. watercourses still occur and these reduce the effectiveness of the programs implemented to date.

- **Others**

Several community groups are becoming frustrated because land alterations that thwart the goals of stream enhancement programs continue. Community support for further stream enhancement programs is at risk.

Working Paper: Mutch, J.P., Micheline Savard, Gary Julien, Barbara MacLean, Bruce G. Raymond, and James A. Doull. 1999. Pesticides in water and sediment: monitoring vs. fish kill investigations on Prince Edward Island. RAP WP 99/80.

Referee: K. Munkittrick

Rapporteur: Rod Bradford

Issues/Concerns (including response):

1) Explained that pesticides bind to the soil and will decay there. Fish kills in 1999 were attributed to a combination of a mild 1998-1999 winter followed by a dry spring that led to higher than usual insect infestation. More pesticide was sprayed. Heavy subsequent rainfall transported sediment (with pesticide) to the watercourse. Thus fish kills are expected after every heavy rainfall.

2) The fate of pesticides delivered to groundwater is not known. Was suggested that water quality monitors could be deployed during future *in-situ* brook trout egg survivorship experiments.

3) The gills of dead fish following a large kill are not inspected. Was suggested these inspections could assist with identification of the cause of mortality; sediment would irritate the gills which should be apparent whereas pesticide poisoning would paralyze the operculum. Rigorous post-mortem diagnostics are lacking.

4) Most water quality measurements are in watercourse that have not experienced fish kills; this makes it more difficult to identify the cause of kills.

5) Pesticide residues are detectable in shellfish in the estuaries. Concentrations measured to date are below those that would prohibit human consumption.

- **Management Consideration**

Sediment originating on agricultural land can serve as a vector for delivery of pesticides and their residues to adjacent watercourses. Dosages can be lethal to aquatic life under certain conditions. Pesticides and their residues are also detectable in groundwater. Their impact on aquatic life occurring where groundwater enters the watercourse is not known, including the effects on brook trout at the sensitive embryonic stage.

Working Paper: Gray, M.A., K.L. Teather, J. Sherry, M. McMaster, and R.E. Mroz. 1999. Endocrine disrupting potential in freshwater ecosystems near agricultural areas on Prince Edward Island. RAP WP 99/81.

Referee: Simon Courtenay

Rapporteur: Andrea Locke

Issues/Concerns (including response):

Note: the oral presentation was given by Bill Ernst.

Q: How dependable or rigorous was the site selection and risk assessment procedure for 1998 work which classified sites as high/medium/low risk based on slope, agricultural use, proximity? This appears to need beefing up.

A: This procedure was semi-quantitative at best. Intending to use SPAD data to quantify exposures in 1999.

Q: Some information, i.e., trout exposures, is not in the document.

A: These will be included.

Q: Any observations of intersex in wild fish?

A: Not observed

Q: Why was only testosterone measured in some experiments, and both estradiol and testosterone in others?

A: This was due to resource limitations.

Q: What was the orientation of cages relative to the current?

A: The cages were end-on to the flow. There was no attempt to standardize flow rates through cages, and swimming energy expended by fish might explain differences in condition factors.

Q: Was 20 fish in 1 x 3 ft cage a high density?

A: This was considered reasonable by Randy Angus. It is also reasonable by John Sprague's exposure criteria.

Q: What about materials used in cage construction, any toxics?

A: There may have been some toxic materials, e.g., in duct tape, etc. But flow rate through the cage would tend to minimize effects of any toxins coming from the cages. This may not have been the case for the control fish held at UPEI. Note that the cages for use in the field were standard construction BUT the control fish at UPEI had a totally different tank setup.

Q: There were three different exposure times of pesticide application to separate which period these effects were most noticeable, but the three times overlap each other at times.

A: That was true in 1998, but the 1999 exposures didn't overlap, they were concurrent.

Q: The testosterone data present means and SE but no N – need to add N.

A: Most N would be 6 to 10.

Q: Why did you compare the control (held at UPEI) to the 1st exposure group but not the other 2?

A: They were not available for the later 2 comparisons, since they had already been sampled.

Q: Why has increase in steroid hormones near mills, etc., been cited as pers comm., with no publications?

A: None of that is published yet.

Q: Could you explain your analysis with rainfall, within groups or pooling groups 1 to 3?

A: We looked at total accumulated rainfall within that group exposure, then tried to correlate with testosterone level and condition, but didn't have site specific rainfall/runoff.

Q: Were data transformed before analysis?

A: No.

Q: The medaka work suggests differences between sites, could you have run negative controls of known sediments or clean sediments?

A: The problem with medaka work is that sediments from each site were not characterized. That will be done this year, and will also consider microtox toxicity tests, etc., for extra site-specific information.

Q: Vials with eggs in them were sealed for 12 days then moved to Petri dishes – why, do you think that hatch was delayed by sealed vials?

A: The late hatch was normal, sometimes takes up to 30 days. Eggs were transferred in case the sediment was causing oxygen to be a limiting factor.

Q: How were some of the calculations done, this is not clear – i.e. 18% did not hatch but mortality was 12%, not clear what denominator was in calculations.

Q: Outline what the next step is, in final paragraph of discussion.

Questions from panel members:

Q: What size were the fish, and where did they come from?

A: Cardigan hatchery, 6 inches long, 18 months old.

Q: Were they reared on well or surface?

A: Don't know.

Q: What were the levels in the fish before they were moved into the sites?

A: The UPEI fish came from the same lot as the first set of fish, so analysis of these should answer that question. However, there may be some effects of feeds, these have been shown in some cases to have endocrine effects.

Q: Do this year's study sites correspond with James' work with exposure field monitoring?

A: No. However, James' sampling is not continuous, but is grab sampling so it might not be very helpful in typifying the exposure field for our fish. This year we will be making more efforts to typify the exposure field. We will be pumping water through columns, etc., to absorb pesticides. This doesn't sample full spectrum, but we will analyse for selected known endocrine disrupters.

Q: What about impacts of other stressors in the streams, e.g. sediments, temperatures?

A: These things affect responses to other toxins, but we don't know if they affect EDC's. We do measure some stream characteristics.

Q: This summer I saw one cage with a dead fish, could this be due to mink or other predators?

A: We didn't see any indications of animal predation. All mortalities were early in the experiments, probably due to handling stress.

Q: What about doing some challenge tests in medaka?

A: The experiments were not controlled experiments with known pesticides, but were exposing the fish to runoff. It would be good to do short-term exposures with known pesticides then transfer to clean water, to simulate a runoff event.

Working Paper: Duffy, T. 1999. Livestock access to Prince Edward Island streams: issues and solutions. RAP WP 99/82.

Referee: Bob Bancroft

Rapporteur: Andrea Locke

Issues/Concerns (including response):

Q: There is more science out there on some of this, would be nice to see it cited or incorporated.

Q: Should this development effort be in a different government agency than the regulatory authority –is it hard to get cooperation?

A: There has been quite a lot of cooperation. Would prefer to see progress made via cooperation rather than enforcement. Prefer to see enforcement done by other agencies.

Q: Some riparian zones were reestablished in Nova Scotia, but the streams were still wastelands. Has there been any follow-up, any in-stream devices?

A: There have been in-stream developments operating concurrently (brush mats, etc).

Comments by panel members:

Q: What is the value of legislation to force farmers to do this?

A: We prefer to get this done on a voluntary basis through incentives and public education. But the program is lacking in funds for advertising and promotion.

Q: Are there community groups involved in community pastures, etc.?

A: Yes, there has been some participation. But the usual situation is participation by farmers as individuals.

Q: What is the distance of fence from river ? Do you consider the slope, the type of soil, etc.?

A: The distance ranges from 3 to 20-30 m, at discretion of the farmer – often determined by topography, anchor posts, etc. Some projects on buffer zones were encouraging 10 m setback.

Q: What is average cost to farmer?

A: About 70% of projects were $2K or less. But lots of the cheaper projects were probably done earliest. Some recent projects were $10-15K . But 66% is covered by provincial government, although earlier projects had an upper limit to the subsidy. There is no upper limit now, which is probably why the more expensive projects are now being done. This covers the cost of fence, setting up watering systems, etc.

Q: Cost of maintaining fence annually may be as much as the original installation.

Q: How do farmers feel about having their cattle drinking stream water that is contaminated with various agri-chemicals? Isn't this a good reason for them to participate?

A: None have ever formally complained of the water quality.

Jill Adams: All her sites are way over the drinking water limits for bacteria.

Q: Maybe community groups could get involved in spending the time to build the fences, free labour via various programs.

Q: Have they prioritized the serious cases?

A: No, they work only with the farmers who were interested, in hopes that this would motivate others.

Working Paper: Adams, J. 1999. Concentrations of faecal coliform bacteria in headwater streams in the Bedeque Bay and Cardigan Bay watersheds. RAP WP/99/83

Referee: Rod Bradford

Rapporteur: Andrea Locke

Issues/Concerns (including response):

Q: Define the distances for upstream and downstream sampling in this study.

A: Normally, downstream means just after the fence, but some sites were a couple of km or more. In the analysis, this is factored in by weighting by watershed size.

Q: Explain the weighting.

A: We multiplied the concentrations by watershed area, as a surrogate for water flow.

Q: On the figures, you need to id sites by forested, cattle fenced, etc.

Q: In Table 3, the sediment concentrations in all sites were high. Can you distinguish between coliforms resuspended in elevated flow vs runoff? You will need to do so especially if getting into typing coliforms.

A: No, didn't distinguish these

Q: What about fields with geese aggregating or when manures being spread?

A: Yes, would like to have more sites that are not just cattle access.

Q: What is the net flux of coliforms? This is not exactly the same question as the study.

A: This could be addressed by a longitudinal study in the river/estuary. This project was not designed to look at the whole watershed, but improve the situation at point sources. For a study of net flux, there would be benefits to having a stream inventory of land use.

Q: Are there plans to replicate point source types?

A: There were sites added in 1999 to replicate fenced sites, etc.

Q: What is public awareness, what was the reception of your suggested study or results?

A: There was no problem getting landowners involved, although they all said I wouldn't find any problems. They are concerned about legislation and money to remediate.

Comments from panel members:

Q: Are coliforms pathogenic?

A: Coliforms themselves not pathogenic, but are used as indicator organisms. There may be a relationship between coliforms and salmonella. Coliforms on an oyster ground may be dangerous even though they didn't originate with humans.

Q: When there are feces there is likely to be urine. Up to 100% of male fish in British streams may have eggs growing in testes due to estrogens in urine in sewage. Intersex may be a concern, also possibility of hormones and pharmaceuticals coming out of livestock.

Q: What about liquid manure spreading?

A: We did not study that.

Q: What about coliforms in sediments vs water, is there an attachment of coliform to the sediment or is it just sitting there among the sediment grains? What is the mechanism of resuspension?

Bruce Raymond: Not sure about the attachment question. Coliforms in both rivers and estuaries more abundant in sediments than water. In the estuaries, there might be tidal resuspension but maybe onshore winds are more important in PEI.

Q: Is there any difference in the results with the size of buffer zone?

A: That's hard to say since the "fenced" sites were already fenced. But there are two remediated sites, may be possible to see if concentrations are decreasing now that cattle are fenced out, and see if buffer zone good enough.

Working Paper: Landry, T. 1999. The potential role of bivalve shellfish in mitigating negative impacts of land use on estuaries. RAP WP 99/84

Referee: Rosie MacFarlane

Rapporteur: Rosie MacFarlane

Issues/Concerns (including response):

Q: Why are shellfish aquaculturists not more vocal about threat of pesticides?

A: They are also under threat. So they may be more reluctant to promoting the benefit of their activities. Should look at the benefits that aquaculture has to the ecosystem. Many people do not distinguish between the reports (negative) of finfish aquaculture and shellfish aquaculture. Assisting in maintaining an equilibrium.

Q: Is there an upper limit in terms of temperature?

A: Have seen high mortality in soft shelled clams. Not clear on cause. Mussels are vulnerable to warming of water temperatures. Growers are better equipped in knowledge, we haven't seen the die offs in 1991 or 1992. It is a concern. Soft shelled clams are important component of the ecosystem and in some areas have seen up to 80% mortality. Economic impact and ecological impacts.

Rick Cunjak: Given the amount of water that shellfish can filter and impurities in the water (pesticides) has anyone used bivalves for "decontaminating" waters?

A: Some good work from San Francisco where they have established bivalve populations in polluted bays. Haven't seen any work on fresh-water side, but would imagine that it would be quite similar. Despite the problems with zebra mussel, it has done a good job cleaning water quality in Lake Erie. Some question as to whether they should be handled as toxic waste. Many

freshwater native mussels in North America are on the brink of endangered list. Their numbers may be too low to be of any help. It might be better to try to clean up water in other ways, rather than using native shellfish.

A lot of problems with populations are because of lower recruitment numbers due to sedimentation. This might be the same for the Pearl Mussel. Big issue for quahogs and oysters. They have to desilt or put in clean substrate on P.E.I., and that is the only way we've been able to maintain the landings. They would be lower if not for the continued enhancement.

Rod Bradford: Reduced biodiversity? Consequence of competition for resources or displacement in immediate vicinity of mussel farm?

A: Not a lot of information. It does change the community below an aquaculture site. Need to start from point zero and look at cumulative effect. Take into consideration on the overall effect, including pelagic increase in diversity. A lot of discussion about this subject, and we aren't well equipped to deal with it. Sounds like a localized effect. Work of Grant and others. Not something demonstrated on an ecosystem level.

How much more economical it would be if they could reduce fall-off of cultured mussels to the bottom. It is related to the variety of mussels, temperature, time of year, etc.

David Cairns: Effects of sedimented bottom on oyster growth. Resummarize the effects of silty bottom on the ability of oysters to grow, impact on shell shape, and questions of siltation of estuaries and its effect on other bivalve species e.g. soft shelled clams and quahogs.

A: Sedimentation will affect bivalves by 1) increased turbidity in the water. Have seen that suspending oysters in water quality where not affected by turbidity. They will grow faster in these areas. 2) Siltation has negative impact on recruitment. Not clear for soft shelled clams but is clear for oysters and quahogs that it is not a positive effect. Work on P.E.I. and elsewhere has clearly shown that without desilting we would quickly lose our oysters. Improves recruitment by 3 to 4 times. Just by having a fishery activity before the set of oyster spat, increases the success by threefold.

Q: Impact on shell shape and marketability?

A: Siltation has been attributed to polydura (worm that tunnels through shell and makes blisters on shell). Presence is associated with amount of silt.

Richard Gallant: Long shape - when oysters are in a lot of sediment, they will try to grow out to feed. On firm bottom, grow in cup shape which is more marketable.

Lee Murphy: Feeding response makes them grow long

David Cairns: Are our heavily silted estuaries a bad thing for those two species compared to deeper water in previous times.

A: In soft shells, see good sets on all types of bottom. Have seen dramatic decrease in soft shelled clams, but not sure if associated with type of sediment. May be directly a result of harvesting, rather than change in bottom type. Work in Chesapeake Bay suggests that siltation has decreased the oyster population substantially.

Lee Murphy: Anecdotal evidence that there is some benefit to working the shell bed to clean off the bed.

Soft shelled clams bore down through sediment and if too compact, won't be able to escape predators or overwinter.

Bruce Raymond: A couple of years ago the province looked at a number of estuaries around P.E.I. for sediment underneath aquaculture. Found that there was little difference. Sediments were mainly anoxic. Quality of sediment no different between aquaculture and non-aquaculture sites.

Bruce Raymond: Less comes out of mussels than goes in. Nitrate inputs seemed to suggest that more was coming out than was going in. T. Landry will check out the numbers.

Q: Any recent reports of domoic acid in P.E.I. waters?

A: Not associated with health issues, but there is monitoring.

Lee Murphy: It is there from time to time. No closures or restrictions since 1992. Background levels (low) have been picked up.

Q: Is the domoic acid problem related to eutrophication issue?

A: Only occurred so few times, so hard to make that conclusion. Not sure if anyone came up with a reason as to why it occurred.

Lee Murphy: These blooms have occurred elsewhere, e.g. southern Nova Scotia.

Richard Gallant: Can bloom and not always be toxic, which is quite common.

Working Paper: Raymond, B. 1999. Trends in nutrient and chlorophyll concentrations in Prince Edward Island estuaries. RAP WP 99/86

Referee: Andrea Locke

Rapporteur: Rosie MacFarlane

Issues/Concerns (including response):

Q: General lack of literature citations in the introduction?

A: Not a lack of sources but lacked time in putting the report together. They would help if included.

Q: Record of frequency of anoxic events?

A: Don't have them and probably not reliable. Respond to a complaint in the community. But, over time, they don't consider it noteworthy. They don't see that government has been able to do anything positive to make it go away, so don't bother to report specific incidences anymore.

Q: Any idea of when the anoxic events went from being relatively rare to relatively common?

A: It is difficult for people to pinpoint the time. Difficult to see tiny changes over a long time. Suspect that it was 10-15 years.

Q: Curious if at that time if there was any difference in the duration of these events?

A: No information on that. Personally don't consider just the obnoxious time to be duration of the event. See quite a bit of macro algae which is likely to be a strong component of the problem. Dissolved oxygen might be difficult to interpret if supersaturated. Once phytoplankton and sea lettuce die off, then estuary may turn white. The white time frame is very short (<week). Then enters a phase where it is dark in colour, not much chlorophyll.

Q: Nutrients in water body during this event?

A: No information available. This might be worth further study.

Q: Page 1, rate at which nutrients are introduced into the system. Any incidences where source might be coastal or offshore?

A: Not aware of any. Didn't point out atmospheric deposition (believed to be added input in some areas). Also on P.E.I., groundwater abundance could be source.

Q: Talk about the causeways that have been linked to anoxic events. Vernon River last of the improvements that can be had with this type of remediation. Any causeways not associated with anoxic events? What proportion actually had anoxia?

A: Not sure how many causeways there actually are. Wheatley River, Kildare River, Pinette River, and estuary to Trout River in New London Bay. Anoxic event and question around bridge structure, not sure if part of the problem.

Q: Nice to have a table to list the estuaries as north/south. Mark on figure where eutrophic cut off. Realize that a pretty large proportion is above the cut off.

Q: If total phosphorus greater than criteria for eutrophication, but estuary is not eutrophic, what does this mean?

A: A little uncomfortable in relying on it. J. Meeuwig came to conclusion that phosphorus is limiting in Mill River estuary. Others not sure that if you look at the totals, that it is the right way to look at it. Might be more relevant to lakes. Organic nitrogen might be refractory (not available) Might be more nitrate limiting than it looks.

Q: Materials and methods hard to follow. Might be worthwhile to add more info as to the time of year that some of these things were sampled, depth in water column, analytical technique, (e.g. autoanalyser, what kind) etc.

Q: Nitrates - historical data prior to 1992 had values below the detection limit. If they are below the detection limit then. If limit hasn't change, can we not say it increased? Limit has changed.

Q: In figures, e.g. ones for the rivers, there are no data points.

A: If put them in, you wouldn't be able to see the lines.

Q: Would be nice to have variability - maybe separate into three separate graphs.

Q: Curve drawing methodology:

A: Comes out of stats package (Lowess). If you have data set with a lot of points and looking for something going through the middle, less sensitive to single, wacked out number.

Q: Are 6-8 samples/year appropriate, given annual/seasonal trends?

A: It is problematic at times. Primary concern was the summertime issue of anoxia, looked at the selection of data unit. July - August - September. Samples done on frequency which would tend to normalize that in the data. In order to make sense of that, need a number of years.

Is it possible to pick out a time of year, just look at those samples going back to the past, to help standardize things. That is not a problem, although it shows the same thing.

Q: Whose criteria are you using for eutrophication? Meeuwig 1998? Presumably older stuff around. Time factor. Reference not the originator of that, was referring to other work.

Q: Speculate as to specific causes of land use problems?

A: Don't want to get into that. Well known that we've had tremendous change in agriculture activity in last 10 years. Difficult to speculate, as to lack of information about things that have changed that wouldn't be just straight land use, hedge rows, equipment size, etc.

In Meeuwig's look at Mill River, seemed to be a change in water quality that was recent enough. She did find that primarily in last 10 years, it was the straw that broke the camel's back. Prior to that it was borderline eutrophic.

Chlorophyll concentrations - mean concentrations when referring to amount linked to eutrophication. We have episodic events well in excess of 20.

Q: Is mean chlorophyll going to be very meaningful when related to anoxia?

A: Seems to be more indication of chronic long term problem. Anoxic is an episodic event, and more likely related to short term rise immediately prior to the event. Would argue that you wouldn't see episodic events of anoxia if estuary already wasn't in bad shape. If just look at anoxic events, one might think that there wasn't a problem at other times.

Lee Murphy: Nutrients that are recycled following early spring flush from landwash. We had no rain in May and June, and with personal observation, normal spring rains give high nutrient loading early and practically anoxic by August. This year was different. Comes down to residence time on North Side.

A: Spring runoff - if phosphorus is limiting, its transport mode is primarily with sediment. Very different than if limiting nutrient is nitrogen. Makes it difficult to draw conclusion at this point.

Shawn Hill: Since the 1980s, trend of nitrate in Dunk has leveled off, but overall total nitrogen is rising. Any speculation as to why?

A: Didn't expect to see. Normally found that total nitrogen and nitrate tend to track each other.

Q: Has it been observed in any other places with long term monitoring?

A: Only 3 sites on PEI

Rick Cunjak: Hard to say if there are seasonal differences in nitrate. Surprised to see the maximum in January for all three rivers. Why?

A: No satisfactory answer for it. In winter, we get significant thaw events and lots of water coming through. When not having thaw events, lots of groundwater which can be enriched by fertilizer applications. Agricultural scientists worried about eutrophication and nutrient issue, they have suggested that potato plants are rather inefficient (use about 40% of fertilizer going on the land). But come spring, all inorganic nitrate in the field is gone. Disappears through runoff. During spring, higher proportion of runoff, nitrate might be gone from surface layer. Surface water coming through. Groundwater might be higher, surface water lower.

Dunk - might be high because high percentage of potato land. What if plotted the numbers of kilometers squared of farm in catchment area. To do that, would have to go through a lot of info from Dept. Agriculture but would be useful. Monitoring on Hillsborough 1990-91. Sampled all the tributaries (half dozen). Consistency at particular sites over the two years, but difference between sites.

Catchment of the two other rivers: Carruthers smaller than Morell, Dunk larger.

Daniel Caissie: Water samples that were analyzed. Were they grab samples?

A: Yes.

Daniel Caissie: Experience is that the data can be quite variable with this type of sampling.

A: Have to make distinction between concentrations and loading. Peaking in winter, concentration could be quite high but if low discharge, amount entering estuary would be quite low. In spring, same concentration, but more water so more could be reaching the estuary.

Q: North-south differences. What about estuary shape?

Affect flushing time. Oceanographers say that what appears to be a barrier doesn't cause much of a change in residence time. Seems like in general, if you can get the water in, that represents the full tidal prism. The barrier doesn't seem to make a big dent. Increased turbulence may actually reduce the resident time somewhat. Doesn't believe that shape if a big factor, but hasn't been specifically looked at it.

Andrea Locke: Any difference between agriculture on north and south side?

A: Heaviest agricultural use on some of the large rivers on the south side, e.g. Dunk, Wilmot. Wheatley River - two groups looked at it. BIO/Acadia and consulting firm that looked at it in the mid-1980s. Bad water quality not due to constriction at the bridge. Doesn't seem to have much of a dent in the residence time.

Appendix 1. List of Participants

Participant	Affiliation/Address	Telephone	Fax	E-mail
Jill Adams	PEI Department of Fisheries, Aquaculture and Environment Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-5179	(902) 368-5830	jdadams@gov.pe.ca
David Aggett	Environment Canada, Queen Square, 45 Alderney Drive Dartmouth, Nova Scotia B2Y 2N6l	(902) 426-1925	(902) 426-8373	dave.aggett@ec.gc.ca
Benji Andrew		(902) 566-9938		
Bob Bancroft	Box 111, RR 7, Antigonish, Nova Scotia B2G 2L4	(902) 386-2501	(902) 386-2517	bancroftreed@auracom.com
Paul Boyd	Oceans Branch, Department of Fisheries and Oceans, 133 Church St., Antigonish Mall, Antigonish, Nova Scotia B2G 2E3	(902) 863-5670		boydp@mar.dfo-mpo.gc.ca
Rod Bradford	Department of Fisheries and Oceans, Bedford Institute of Oceanography, Box 1006, Dartmouth, Nova Scotia B2Y 4A2	(902) 426-4555	(902) 426-3479	bradfordr@mar.dfo-mpo.gc.ca
David Cairns	Science Branch, Department of Fisheries and Oceans, Box 1236, Charlottetown, Prince Edward Island C1A 7M8	(902) 566-7825	(902) 566-7948	cairnsd@dfo-mpo-gc.ca
Daniel Caissie	Science Branch, Department of Fisheries and Oceans, Box 5030, Moncton, New Brunswick E1C 9B6	(506) 851-6287	(506) 851-2147	caissied@dfo-mpo.gc.ca
Michael Carmichael	PEI Dairy Producers' Association	(902) 855-2684		
Simon Courtenay	Oceans Branch, Department of Fisheries and Oceans, Box 5030, Moncton, New Brunswick E1C 9B6	(506) 851-6709		courtenays@mar.dfo-mpo.gc.ca
Richard Cunjak	Biology Department, University of New Brunswick Fredericton, New Brunswick E3B 6E1	(506) 452-6204	(506) 453-3583	cunjak@unb.ca
R. Allen Curry	New Brunswick Cooperative Fish and Wildlife Research Unit, University of New Brunswick, Fredericton, New Brunswick E3B 6E1	(506) 452-6208	(506) 453-3583	racurry@unb.ca
Ron deHaan	Department of Agriculture and Forestry, Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-5642		krdehaan@gov.pe.ca
André Ducharme	Department of Fisheries and Oceans, Bedford Institute of Oceanography, Box 1006, Dartmouth, Nova Scotia B2Y 4A2	(902) 426-3909		moira.andre@ns.sympatico.ca
Tommy Duffy	Ducks Unlimited Canada, c/o Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-4667	(902) 368-5830	tjduffy@gov.pe.ca
Dave Duggan	Oceans and Coastal Management, Department of Fisheries and Oceans, Bedford Institute of Oceanography, Box 1006, Dartmouth, Nova Scotia B2Y 4A2	(902) 426-6183		duggand@mar.dfo-mpo.gc.ca
Todd Dupuis	Atlantic Salmon Federation, c/o PEI Department of Fisheries, Aquaculture and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-4667	(902) 368-5830	tddupuis@gov.pe.ca
W.R. Ernst	Environment Canada, Queen Square, 45 Alderney Drive, Dartmouth, Nova Scotia B2Y 2N6	(902) 426-5048	(902) 426-8373	bill.ernst@ec.gc.ca

Participant	Affiliation/Address	Telephone	Fax	E-mail
Gary Fournier	Auld Creek Environmental Committee	((02) 629-1668		
Richard Gallant	PEI Department of Fisheries Aquaculture, and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-5524	(902) 368-5542	rkgallant@gov.pe.ca
Mark Gloutney	Ducks Unlimited Canada, P.O. Box 430, # 64 R.R. 6, Amherst, Nova Scotia B4H 3Z5	(902) 667-8726	(902) 667-0916	m_gloutney@ducks.ca
Carole Godin	Oceans Act Coordination Office, Department of Fisheries and Oceans, Box 5030, Moncton, New Brunswick E1C 9B6	(506) 851-2485	(506) 851-6579	godinc@mar.dfo-mpo.gc.ca
Marc Godin	Department of Fisheries and Oceans, C.P. 3420, Tracadie, New Brunswick E1X 1G5	(506) 395-7700		godinm@dfo-mpo.gc.a
Michelle Gray	Biology Department, University of New Brunswick, Fredericton, New Brunswick E3B 6E1	(506) 455-0994	(506) 453-3583	r55me@unb.ca
Ron Gray	Oceans Branch, Department of Fisheries and Oceans, Box 5030, Moncton, New Brunswick E1C 9B6	(506) 851-6979		grayr@mar.dfo-mpo.gc.ca
Daryl Guignion	Biology Department, University of Prince Edward Island, Charlottetown, Prince Edward Island C1A 4P3	(902) 566-0676	(902) 566-0740	dguignion@upei.ca
Denis Haché	Fisheries Habitat Management, Department of Fisheries and Oceans, Box 5030, Moncton, New Brunswick E1C 9B6	(506) 651-6252		hached@mar.dfo-mpo.gc.ca
Shawn Hill	Department of Fisheries, Aquaculture, and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7M8	(902) 887-3014		
Thomas Landry	Science Branch, Department of Fisheries and Oceans, Box 5030, Moncton, New Brunswick E1C 9B6	(506) 851-6219		landryt@dfo-mpo.gc.ca
Andrea Locke	Oceans Branch, Department of Fisheries and Oceans, Box 5030, Moncton, New Brunswick E1C 9B6	(506) 851-6248	(506) 851-2079	lockea@mar.dfo-mpo.gc.ca
Gerald MacDougall	PEI Department of Fisheries, Aquaculture and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-4808,	(902) 368-5830	dgmacdougall@gov.pe.ca
Rosanne MacFarlane	PEI Department of Fisheries, Aquaculture and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-6080		rmacfarlane@upei.ca
John MacMillan	Inland Fisheries Division, Department of Fisheries and Aquaculture, Box 700, Pictou, Nova Scotia B0K 1H0	(902) 485-7023	(902) 485-4014	macmiljl@gov.ns.ca
Scott MacNeill	Ganaraska Regional Conservation Authority, Port Hope, Ontario L1A 4W4	(905) 885-8173	(905) 885-9824	smacneill@mailexcite.com
Jessica Meeuwig	Biology Department, 1205 Dr. Penfield Avenue McGill University, Montreal, Quebec H3A 1B1	(514) 398-6410	(514) 398-5069	jmeeuw@po-box.mcgill. ca
Kelly Munkittrick	Biology Department, University of New Brunswick Fredericton, New Brunswick E3B 6E1	(506) 452-6219	(506) 453-3583	krm@unb.ca
Clair Murphy	Department of Fisheries, Aquaculture, and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7M8	(902) 368-5036	(902) 368-5471	ccmurphy@gov.pe.ca

Participant	Affiliation/Address	Telephone	Fax	E-mail
Leaming Murphy	Oceans Branch, Department of Fisheries and Oceans, Box 1236, Charlottetown, Prince Edward Island C1A 7M8	(902) 566-7839	(902) 566-7948	murphyl@mar.dfo-mpo-gc.ca
Jamie Mutch	PEI Department of Fisheries, Aquaculture and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-5599	(902) 368-5830	jpmutch@gov.pe.ca
Irené Novaczek		(902) 964-2781		inova@isn.net
Carole Payne	Communications Branch, Department of Fisheries and Oceans, Box 5030, Moncton, New Brunswick E1C 9B6	(506) 851-7045		
Josh Perry	Trout River Environmental Committee	(902) 963-3174		
Terry Perry	Trout River Environmental Committee	(902) 621-0637		
Becky Petersen	Boughton River Watershed Enhancement Association	(902) 583-3324	(902) 583-3324	
Ted Potter	Oceans Branch, Department of Fisheries and Oceans, Bedford Institute of Oceanography, Box 1006, Dartmouth, Nova Scotia B2Y 4A2	(902) 426-2155	(902) 426-3855	pottert@mar.dfo-mpo.gc.ca
Bruce Raymond	PEI Department of Fisheries, Aquaculture and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-5054	(902) 368-5830	bgraymond@gov.pe.ca
Joan Reid	Habitat Management, Department of Fisheries and Oceans, Coast Guard College, Box 1085, Sydney, Nova Scotia B1P 6J7	(902) 564-7708		reidj@mar.dfo-mpo.gc.ca
John Ritter	Science Branch, Department of Fisheries and Oceans, Bedford Institute of Oceanography, Box 1006, Dartmouth, Nova Scotia B2Y 4A2	(902) 426-3136	(902) 426-3479	ritterj@mar.dfo-mpo.gc.ca
Guy Robichaud	Department of Fisheries and Oceans, Box 5030, Moncton, New Brunswick E1C 9B6	(506) 851-2993		robichaudg@mar.dfo-mpo.gc.ca
Art Smith	Department of Fisheries, Aquaculture and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7M8	(902) 368-6083	(902) 368-5471	hasmith@gov.pe.ca
Bruce Smith	PEI Department of Fisheries, Aquaculture and Environment, Box 2000, Charlottetown, Prince Edward Island C1A 7N8	(902) 368-6081	(902) 368-5830	bmsmith@gov.pe.ca
Kevin Teather	Biology Department, University of Prince Edward Island, Charlottetown, Prince Edward Island C1A 4P3	(902) 566-0325	(902) 566-0740	kteather@upei.ca
Wes White	Department of Fisheries and Oceans, Bedford Institute of Oceanography, Box 1006, Dartmouth, Nova Scotia B2Y 4A2			

Appendix 2. Invitation Letter

Author name
Author address

Dear Author:

This is to formally invite you to participate as a contributor and panel member in the workshop entitled "Effects of land use practices on fish, shellfish, and their habitats in Prince Edward Island." The workshop will take place in Charlottetown from 6 to 10 December 1999.

This workshop, which is sponsored by the Department of Fisheries and Oceans in collaboration with the government of Prince Edward Island, will bring together the best available scientific expertise in the field. In addition to the detailed documentation provided by individual papers such as your own, we expect that the workshop will produce an authoritative concensus statement on the nature and consequences of interactions between land use and aquatic resources on PEI, and on mitigative measures that will reduce negative effects.

Your paper, as currently listed, is entitled "_____."

The local convenor of this workshop is David Cairns. David will shortly be providing you with further details on the workshop agenda, and he will be working with you to ensure that your contribution will help meet the meeting's objectives.

I believe that this workshop will make a very positive contribution to scientific understanding of land use effects on aquatic resources, and I look forward to seeing you in Charlottetown.

With best wishes,

John Ritter
Manager
Diadromous Fish Division
Maritimes Region

Appendix 3. Meeting Schedule

Monday, 6 December, 10:30

Welcome, introductions, workshop objectives and structure (John Ritter, David Cairns, André Ducharme)

Monday, 6 December, 11:00 (rapporteur: D. Caissie)

Overview

Land use and aquatic resources of Prince Edward Island streams and estuaries - an introduction. David Cairns, Department of Fisheries and Oceans, Charlottetown. (referee B. Smith)

Monday, 6 December, 13:00 (rapporteur S. MacNeill)

Estuarine eutrophication

Predicting estuarine eutrophication in Prince Edward Island from land use patterns. Jessica Meeuwig, McGill University (presented by B. Raymond) (referee R. Bradford)

Regulatory environment

Acts, regulations, and policies pertaining to protection of aquatic environments on Prince Edward Island. David Aggett[a], Gerard MacDougall[b], and Leaming Murphy[c] [a]Environment Canada, Dartmouth; [b]PEI Department of Technology and Environment; [c]Department of Fisheries and Oceans, Charlottetown (referee D. Cairns)

Siltation

Substrate sedimentation and salmonid densities in Prince Edward Island streams. David Cairns, Department of Fisheries and Oceans, Charlottetown (referee B. Bancroft)

Substrate composition in the Morell River and other Maritime Province rivers: potential implications for Atlantic salmon fry emergence Daniel Caissie[a] and Eric Arseneau[b] [a]Department of Fisheries and Oceans, Moncton [b]Université de Moncton (referee D. Cairns) (*RAP WP 99/70)*

Tuesday, 7 December, 8:30 (rapporteur R. MacFarlane)

Siltation (continued)

Soil erosion on Prince Edward Island. Ron deHaan, PEI Department of Agriculture and Forestry (referee B. Raymond)

Abundance of juvenile brook trout and sediment in Prince Edward Island streams. Scott MacNeill and R. Allen Curry, University of New Brunswick (referee R. Gray)

Brook trout survival to emergence in relation to sediment in Prince Edward Island streams. Scott MacNeill and R. Allen Curry, University of New Brunswick (referee S. Courtenay) (*RAP WP 99/73)*

Tuesday, 7 December, 13:00 (rapporteur R. Bradford)

Siltation (continued)

Survival of eggs and alevins of wild brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) in relation to fine sediment deposition. Rick Cunjak[a], Daryl Guignion[b],

Roseanne MacFarlane[b], and Randy Angus[c]. [a]University of New Brunswick; [b]University of PEI; [c]Cardigan Hatchery. (referee J. MacMillan)

Physical watercourse enhancement on PEI: methods, extent, and effects on habitats and biota. Roseanne MacFarlane[a], Bruce Smith[a], and Todd Dupuis[b]. [a]PEI Department of Technology and Environment, [b]Atlantic Salmon Federation (referee D. Guignion) (*RAP WP 99/79)*

Toxic chemicals

Pesticides in water and sediment: monitoring vs. fish kill investigations on Prince Edward Island. James P. Mutch[a], Micheline Savard[b], Gary Julien[b], Barbara MacLean[a], Bruce G. Raymond[a], and James A. Doull[c]. [a]Prince Edward Island Department of Technology and Environment, [b]Environment Canada, Dartmouth, [c]Environment Canada, Moncton (referee K. Munkittrick) (*RAP WP 99/80)*

Wednesday, 8 December 8:30 (rapporteur A. Locke)

Toxic chemicals (continued)

Endocrine disrupting potential in freshwater ecosystems near agricultural areas on Prince Edward Island. M.A. Gray[a], K.L. Teather[b], J. Sherry[c], M. McMaster[c], R.E. Mroz[e] [a]University of New Brunswick; [b]University of Prince Edward Island; [c]Canadian Centre for Inland Waters, Burlington; [d]Environment Canada, Dartmouth (referee S. Courtenay) (*RAP WP 99/81)*

Livestock and their wastes

Livestock access to watercourses: issues and solutions. Tommy Duffy, PEI Department of Technology and Environment. (referee B. Bancroft) (*RAP WP 99/82)*

Concentrations of faecal coliform bacteria in headwater streams in the Bedeque Bay and Cardigan Bay watersheds. Jill Adams, PEI Department of Technology and Environment. (referee R. Bradford) (*RAP WP 99/83)*

Wednesday, 8 December, 13:30 (rapporteur J. MacMillan)

Estuarine processes

The potential role of bivalve shellfish in mitigating negative impacts of land use on estuaries. T. Landry, DFO, Moncton. (referee R. MacFarlane) (*RAP WP 99/84)*

Nutrient and chlorophyll trends in PEI estuaries. Bruce Raymond, PEI Department of Technology and Environment. (referee A. Locke) (*RAP WP 99/86)*

Thursday, 9 December, and Friday, 10 December

Preparation and revision of Habitat Status Report

Appendix 4. List of Documents Tabled

Adams, J. 1999. Concentrations of faecal coliform bacteria in headwater streams in the Bedeque Bay and Cardigan Bay watersheds. RAP WP 99/83

Aggett, D., G. MacDougall, and L. Murphy. 1999. Acts, regulations, policies and guidelines pertaining to the protection of aquatic environments on Prince Edward Island. RAP WP 99/68.

Cairns, D. 1999. Land use and aquatic resources of Prince Edward Island streams and estuaries - an introduction. RAP WP 99/66.

Cairns, D. 1999. Substrate sedimentation and salmonid densities in Prince Edward Island streams. RAP WP 99/71.

Caissie, D., and E. Arseneau. 1999. Substrate composition in the Morell River and other Maritime Province rivers: potential implications for Atlantic salmon fry emergence. RAP WP 99/70.

Cunjak, R., D. Guignoin, R. MacFarlane, and R. Angus. 1999. Survival of eggs and alevins of wild brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) in relation to fine sediment deposition. RAP WP 99/74.

deHaan, R. 1999. Soil erosion on Prince Edward Island. RAP WP 99/69.

Duffy, T. 1999. Livestock access to Prince Edward Island streams: issues and solutions. RAP WP 99/82.

Gray, M.A., K.L. Teather, J. Sherry, M. McMaster, and R.E. Mroz.Endocrine. 1999. Disrupting potential in freshwater ecosystems near agricultural areas on Prince Edward Island. RAP WP 99/81.

Landry, T. 1999. The potential role of bivalve shellfish in mitigating negative impacts of land use on estuaries. RAP WP 99/84

MacNeill, S., and R.A. Curry. 1999. Abundance of juvenile brook trout (*Salvelinus fontinalis*) and sediment in Prince Edward Island streams. RAP WP 99/72

MacNeill, and R.A. Curry. 1999. Effects of sediment on juvenile brook trout survival to emergence. RAP WP 99/73.

Meeuwig, J. 1999. Predicting estuarine eutrophication in Prince Edward Island from land use patterns. RAP WP 99/67.

Mutch, J.P., M. Savard, G. Julien, B. MacLean, B.G. Raymond, and J.A. Doull. 1999. Pesticides in water and sediment: monitoring vs. fish kill investigations on Prince Edward Island. RAP WP 99/80.

Raymond, B. 1999. Trends in nutrient and chlorophyll concentrations in Prince Edward Island estuaries. RAP WP 99/86

Smith, B., T. Dupuis, and R. MacFarlane. 1999. Physical watercourse enhancement on PEI: methods, extent, and effects on habitats and biota. RAP WP 99/79.

Appendix 5. List of Research Recommendations

- PEI-specific data on land use impacts on aquatic resources are very limited. To evaluate land use impacts where current understanding is insufficient and to guide mitigative efforts and rehabilitation of PEI's freshwater and estuarine fisheries resources, an integrated, coordinated, and long-term research program is required.

- Research should be directed towards:
  - monitoring the inputs of sediment, toxic chemicals, animal wastes including bacteria, and nutrients into PEI watercourses,
  - quantifying and modeling effects of these inputs on fish, shellfish, and their habitats,
  - establishing benchmarks to support enforcement of legislation, and
  - evaluating existing and devising new mitigative measures.